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Shifting Visual Perspective During Memory Retrieval Reduces the Accuracy of Subsequent Memories

Petra Marcotti and Peggy L. St. Jacques

School of Psychology, University of Sussex, Brighton, BN1 9QH, UK

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Corresponding Author:
Dr. Peggy L. St. Jacques
School of Psychology
Pevensey 1, Room 2C5
Brighton, UK BN1 9QH
Phone: +44 (0) 1273 873878
Email: p.stjacques@sussex.ac.uk

Abstract

Memories for events can be retrieved from visual perspectives that were never experienced, reflecting the dynamic and reconstructive nature of memories. Characteristics of memories can be altered when shifting from an *own eyes* perspective, the way most events are initially experienced, to an *observer* perspective, in which one sees oneself in the memory. Moreover, recent evidence has linked these retrieval-related effects of visual perspective to subsequent changes in memories. Here we examine how shifting visual perspective influences the accuracy of subsequent memories for complex events encoded in the lab. Participants performed a series of mini-events that were experienced from their own eyes, and were later asked to retrieve memories for these events while maintaining the own eyes perspective or shifting to an alternative observer perspective. We then examined how shifting perspective during retrieval modified memories by influencing the accuracy of recall on a final memory test. Across two experiments, we found that shifting visual perspective reduced the accuracy of subsequent memories and that reductions in vividness when shifting visual perspective during retrieval predicted these changes in the accuracy of memories. Our findings suggest that shifting from an own eyes to an observer perspective influences the accuracy of long-term memories.

Key Words: memory for events, episodic memory, visual perspective, accuracy, updating, reactivation

Introduction

Memories are reconstructed through active retrieval processes that can reshape our experience of the past in multiple ways. One of the most fascinating ways we reconstruct memories is by recalling the past from multiple visual perspectives. Although we typically experience the world from a first person in-body perspective (i.e., from our own eyes), we sometimes retrieve memories from a first person out-of-body perspective (i.e., observing our physical body from the outside (Nigro & Neisser, 1983). By definition, observer perspectives reflect vantage points that are not typically experienced during memory encoding. The ability to retrieve memories from visual perspectives that were never experienced can thereby provide insight regarding the dynamic nature of memories (Schacter, 1996). Supporting this idea, a large body of evidence has shown that remote memories are typically remembered from an observer perspective, whereas recent memories are more likely to be naturally retrieved from an own eyes perspective (e.g. Frank & Gilovich, 1989; Nigro & Neisser, 1983; Piolino et al., 2006; Rice & Rubin, 2009; Robinson & Swanson, 1993; Talarico et al., 2004). One reason is that remote memories are more likely to have undergone modifications over the course of time when compared to recent memories, in line with theories of memories that emphasize the critical role of reactivation in shaping long-term memory representations (Mcclelland, Mcnaughton, & Oreilly, 1995; Winocur & Moscovitch, 2011). Although memories are typically retrieved from a natural or preferred visual perspective, people can flexibly adopt multiple visual perspectives and shift back and forth between them (Rice & Rubin, 2011). Manipulating visual perspective during memory retrieval, thus, provides an experimentally tractable way to investigate reconstructive processes that potentially modify memories. Here we investigate how shifting visual perspective during retrieval of memories for complex events encoded in the laboratory influences subsequent memory accuracy.

A number of studies have shown that the particular visual perspective adopted during memory retrieval influences the characteristics of memory recall (for review see Rice, 2010). A seminal study conducted by Nigro and Neisser (1983) demonstrated that the visual perspective people adopt depends on the type of phenomenal elements they recall. More specifically, when participants were asked to focus on the emotions elicited by their autobiographical memories, they tended to adopt an own eyes perspective, whereas the observer vantage point was associated with a focus on the objective circumstances or physical context of the event. Visual perspective also influences the types of information recalled in memories (Anderson & Pichert, 1978; Bagri & Jones, 2009; Eich, Nelson, Leghari, & Handy, 2009; McIsaac & Eich, 2002, 2004). For example, McIsaac and Eich (2002) examined how visual perspective during retrieval of complex events encoded in the lab affects the content of verbal recall. They found that memories retrieved from an own eyes perspective contained more details related to internal aspects of the memory (i.e., sensations experienced, emotions and thoughts). In contrast, memories retrieved from an observer perspective included a greater number of details related to external aspects of the events (i.e., statements about the subject's personal appearance, the actions performed and the spatial relations among the objects). These findings are consistent with research demonstrating that adopting an own eyes compared to an observer perspective leads to a more detailed account of emotions associated with memory retrieval (Berntsen & Rubin, 2006; D'Argembeau, Comblain, & Van der Linden, 2003; Holmes, Coughtrey, & Connor, 2008; Nigro & Neisser, 1983; Sutin & Robins, 2010; Talarico, LaBar, & Rubin, 2004; Vella & Moulds, 2014). Other research has suggested that adopting an own eyes perspective leads to greater focus during memory retrieval on the concrete aspects of events, whereas the observer perspective involves greater attention to more abstract features (Libby & Eibach, 2011).

Shifting visual perspective during retrieval, by changing from a preferred or dominant perspective to a non-preferred or alternative perspective, also affects the characteristics of memory retrieval. For example, Robinson and Swanson (1993) asked participants to classify a series of autobiographical events as either own eyes or observer memories, to rate their original as well as their current emotional intensity, and then to recall them again two weeks later from either the original perspective or from the alternative vantage point. Their findings revealed that shifting perspective from an own eyes to an observer perspective yielded a significant decrease in reported affect, whereas shifting in the opposite direction, from an observer to an own eyes vantage point, did not increase emotional intensity ratings (also see Berntsen & Rubin, 2006; Vella & Moulds, 2014). Additionally, shifting from an own eyes to an observer perspective can sometimes reduce the vividness of memory recall (Butler, Rice, Wooldridge, & Rubin, 2016; Rice & Rubin, 2009; Vella & Moulds, 2014).

A handful of studies have also demonstrated that online changes in memory retrieval as the result of actively shifting visual perspective can persist in the phenomenological experience of subsequent memories. For example, Sekiguchi and Nonaka (2014) asked participants to shift from an own eyes to an observer perspective and found a reduction in subjective reports of emotional intensity during memory retrieval that persisted in memories retrieved one month later. Butler and colleagues (2016) examined how repeatedly shifting visual perspective during retrieval of mini-events and recent autobiographical memories over several weeks influenced subjective ratings of memories when compared to initial ratings. They found that repeatedly retrieving memories from an observer vantage point reduced the subjective sense of vividness and recollection associated with memories. Moreover, changes in memories due to repeatedly shifting to an observer perspective persisted even when participants were later asked to shift back to an own eyes perspective. Butler and colleagues (2016) suggested that there was a loss of visual information in memories when repeatedly shifting to an observer perspective during memory retrieval. Similarly, St. Jacques, Szpunar, and Schacter (2017) asked participants to repeatedly shift from a dominant own eyes to an observer perspective during retrieval of autobiographical memories. After actively shifting visual perspective during retrieval, they found that memories initially experienced from a dominant own eyes perspective were more likely to be more spontaneously retrieved later from an observer perspective, when compared to dominant own eyes memories in which the same visual perspective was maintained during retrieval or to baseline memories that had not been previously retrieved. Critically, St. Jacques et al. (2017) also linked these subsequent memory changes in visual perspective to online behavioural and neural changes when participants were instructed to actively shift perspective during memory retrieval.

Taken together the evidence reviewed here suggests that shifting visual perspective during retrieval can modify the phenomenology of subsequent memories. An important, but unanswered question, is whether actively shifting visual perspective during retrieval also influences the accuracy of subsequent memories. If shifting perspective during retrieval reduces the amount of visual information in memories, than adopting an alternative vantage point could also decrease the number of accurate details one remembers about the original event (also see Sutin & Robins, 2008). Previous research, however, has found mixed findings regarding the influence of actively shifting visual perspective on memory accuracy. On the one hand, some research has suggested that adopting an alternative visual perspective benefits accurate memory recall. For example, the classic burglar and homebuyer perspective study by Anderson and Pichert (1978) demonstrated that adopting another individual's perspective (i.e., a homebuyer if you originally adopted a burglar perspective) contributed to the recall of additional memory details, which boosted overall memory accuracy. The potential beneficial effect of adopting an alternative perspective on accurate memory recall is also evident in the *change in perspective* mnemonic included in the cognitive interview, a technique developed to help law enforcement officials increase the total amount of correct information in eyewitness statements in which people are typically instructed to adopt the alternative perspective of another individual in the memory (Geiselman et al., 1984). On the other hand, other research suggests that shifting visual perspective can have a detrimental effect on accurate memory recall. For example, the change in perspective mnemonic in the cognitive interview has not consistently been shown to improve memory accuracy (Boon & Noon, 1994), and some researchers have suggested it could even increase errors and other distortions in memories (Bekerian & Dennett, 1993; Memon, 1999). Additionally, Bagri and Jones (2009) investigated the effect of visual perspective on memory recall for written passages, and found that retrieval from an own eyes compared to an observer perspective led to greater memory accuracy. This research, however, has mainly focused on how taking another individual's perspective (i.e., theory of mind), rather than how shifting one's egocentric (i.e., self-centred) perspective, influences memory accuracy. Moreover, it has not examined the long-term effects of shifting visual perspective on subsequent memory accuracy.

Only one study, to our knowledge, has examined how visual perspective during retrieval influences subsequent memory accuracy. St. Jacques and Schacter (2013; Experiment 2) asked participants to recall memories for a guided museum tour that were cued using photos in which the visual perspective was the same as encoding (i.e., photo taken from the participant's perspective during the tour) or showed an altered perspective (i.e., photo taken from a different angle than the participant's perspective during the tour). On a subsequent recognition memory test a couple of days later they found that memories for tour events that were cued using photos from the same visual perspective as encoding were more accurately recognized. However, participants were not explicitly instructed to shift visual perspective in this study. Thus, it is unclear whether the reported difference in subsequent memory accuracy was due to differences in the visual perspective of memories during retrieval or due to differences in the effectiveness of the altered photo cue to reactivate memories (i.e., encoding specificity; Tulving & Thomson, 1973).

The aim of the current study was to directly examine how actively shifting visual perspective during memory retrieval influences the accuracy of subsequent memory recall for complex and realistic events, and whether potential differences in subsequent memory accuracy due to perspective shifting are related to the effectiveness of retrieval cues to elicit memories. We developed a mini-events paradigm in which participants were asked to perform a series of tasks created in the laboratory, which consisted of hands-on and actively engaging tasks replete of physical actions, sensorial elements and visual details. About a week later, they were exposed to a perspective manipulation during memory retrieval, whereby participants were asked to mentally reinstate some of the mini-events from an own eyes perspective and others from an observer perspective, thus maintaining or shifting their visual perspective, respectively. Two days later in session 3, memory accuracy was tested using a series of short-answer questions about different elements of memory specific to the mini-tasks. On the basis of the research reviewed above, we hypothesised that visual perspective during memory retrieval would influence the accuracy of subsequent memories. Specifically, we predicted that shifting perspective, by retrieving memories originally encoded from an own eyes perspective from an observer perspective, would reduce the accuracy of subsequent memories. Two experiments were included to test this prediction.

Experiment 1

In this experiment, we used photos of the events taken from own eyes and observer perspectives as cues to retrieve memories for events from a non-shifted (i.e., own eyes) and shifted (i.e., observer) perspective, respectively. Previous studies have suggested that shifting to an observer perspective is more difficult than maintaining an own eyes perspective (e.g., Eich et al., 2009). One reason for this may be that any one of a number of observer perspectives can be adopted (e.g., Rice & Rubin, 2011). We reasoned that including photos taken from the particular perspective being manipulated would potentially decrease differences in difficulty between the conditions by providing the exact viewpoint participants were instructed to adopt.

Method

Participants

Twenty fluent English speakers were included in the experiment [16 women; mean age in years (*M*) = 21.65, *SD* = 2.70; mean years of education (*M*) = 16.55, *SD* = 1.79]. They reported no history of psychiatric and/or mental health impairments, were not taking any medication that could affect cognitive function, and had normal or corrected to normal vision/hearing. They provided written informed consent for a protocol approved by the School of Psychology at the University of Sussex.

Procedure

The study involved three separate study sessions. In session 1, participants performed 24 mini-events lasting two minutes each. The mini-events consisted of a series of hands-on, unique and actively engaging tasks with small objects (e.g. shaping play dough to create a beach scene; for list of events see Appendix A). Critically, the mini-events were created to be replete of physical actions (e.g., using pliers to operate a shredder, using tweezers to remove miniature shoes from boxes, using a whisk to mix paint ingredients, etc.), visual details (i.e. objects' colour, shape, pattern), and sensorial details (e.g., smell of honey of shoe polish, clanking noise of watering can, feeling of rubbery gel frogs, etc.). To ensure that the sensorial detail was sufficiently prominent, smells and fragrances were added immediately prior to the start of session 1 to those objects that did not already possess a natural smell (e.g., bubble gum soap to sponges). The order of the mini-events performed was randomly assigned across participants.

During session 1, objects comprising each mini-event were presented on separate trays along with the unique title of each task (e.g., Polish the Shoes; see Figure 1). Participants were instructed to look carefully at the titles for each mini-event, and attend to the physical actions and physical sensations they experienced. Participants were guided through the actions of each mini task by the experimenter, who read the titles and instructions of each mini-task once to familiarize the participant with the mini-event and then a second time while the participant followed along by completing the steps as instructed (see Appendix B for example of descriptions). An example mini-event was presented first in order to familiarize participants with the procedures. The experimenter timed each mini-event and prompted participants to keep the right pace so that each lasted approximately two minutes.

In session 2, approximately one week later [mean delay (*M*) = 6.6, *SD* = .99], participants were presented with titles and photos of the mini-event and asked to retrieve memories while adopting either the own eyes or observer perspective depicted in the photos. Specifically, participants were instructed: "If the perspective is own eyes, mentally reinstate your memory for the event as if seeing it again through your own eyes. If the perspective is observer, mentally reinstate your memory for the event as if viewing it from the perspective of a spectator or observer, watching yourself in the remembered event." Thus, in the non-shifted perspective condition, memories were retrieved from the same own eyes perspective that memories were encoded from, whereas in the shifted perspective condition memories were retrieved from an alternative visual perspective from encoding. A digital camera was used to photograph each mini-event from both an own eyes perspective (taken from the viewpoint of the participant) and an observer perspective (photo taken from the perspective of someone sitting across from the participant; see Figure 1). Each photo depicted the mini-event as it would have appeared to participants at the start of testing in session 1, and participants were instructed to recall the task they had conducted in as much detail as possible.

INSERT FIGURE 1 HERE

Eight mini-events were retrieved in each of the shifted and non-shifted conditions. Participants were given 7.5 s to retrieve each memory and each mini-event was repeated four times in an interleaved fashion. Immediately following each retrieval trial, participants were given 2.5 s each to rate on 5-point scales (1=low to 5=high) how consistently they could maintain the indicated perspective and how vivid their memory was. The timing of the task was based on previous studies that examined retrieval and manipulation of memories for complex events (Szpunar, St Jacques, Robbins, Wig, & Schacter, 2014; St. Jacques, Szpunar, & Schacter, 2017), and we conducted further pilot testing to ensure that participants had sufficient time for memory retrieval. Sixteen mini-events were retrieved during session 2, and the remaining 8 mini-events were used in a baseline condition to assess potential changes in memory due to delay.

In session 3, two days later, memory accuracy for the mini-events was assessed using a cued-recall memory test. Participants were presented with the titles of all 24 mini-events and asked a series of 15 short-answer comprehensive questions about the mini-event related to the physical actions they conducted (e.g., *How did you add the powder to the bottle?* Answer: *with a funnel*), physical sensations (e.g., *What did the container smell like?* Answer: coffee), visual details (e.g., *What colour was the present?* Answer: Red), temporal order of the actions to complete the task (e.g., *When did you seal the box?* Answer: last action), and spatial relations of objects with respect to one another and to one's self (e.g., *Where was the box with respect to where you were sitting?* Answer: centre). Participants were instructed to provide a correct response by typing short answers and to try as best as possible to answer all questions (or to leave it blank if the answer could not be recalled). The average proportion of correct responses on the short-answer questions for each mini-event was then calculated and averaged across trials in each perspective condition. The order of presentation of the mini-events was randomized across participants, and the order of questions asked within each mini-event was also randomized. Following the short-answer questions for each mini-event, participants were asked to provide subjective ratings on a 7-point scale (1=low to 7=high) on the following characteristics: sense of reliving, emotional intensity, the visual perspective from which they remembered the event (separately for own eyes and observer), the degree of visual details, the degree to which their memories involved recall of physical sensations (sound, touch, smell), and physical actions, the clarity of temporal order of actions and spatial arrangements of objects, and how accurate they felt their memory was (i.e., recalling all the details of the event exactly as they occurred). Both the cued-recall and subjective rating tasks were self-paced.

Correct responses to the short-answer questions were coded by the experimenter. We used a conservative approach,[1] whereby a response was coded as correct only if precisely matched the mini-event in question (e.g., *How did you mix the ingredients?* Correct Answer: *With a whisk*, Incorrect Answer: *By stirring*). The total number of correct responses within each detail category for each perspective conditions was summed and the proportion of correct responses was calculated separately for each participant.

Results

Subjective Ratings

Session 2. To determine potential differences in the subjective ratings made during retrieval in session 2, we conducted paired t-tests between the perspective conditions separately on perspective maintenance and vividness ratings (for means and SD see Table 1). There was a significant difference in perspective maintenance between the non-shifted and shifted perspective conditions, $t(19) = 4.43$, $p < .001$, $d = .99$. There was also a significant difference in vividness between the non-shifted, and shifted perspective conditions, $t(19) = 2.73$, $p = .01$,

[1] Adopting a more liberal approach showed similar effects to the conservative one, thus only analyses using the conservative approach are reported in detail here.

d = .61. Thus, despite using photo cues depicting the perspective to be adopted, participants still found it more difficult to maintain the shifted perspective than the non-shifted perspective during memory retrieval, which was also less vivid.

INSERT TABLE 1 HERE

Session 3. Separate repeated measures ANOVAs on the non-shifted, shifted and baseline conditions were conducted on subjective ratings (for means and SD see Table 2). There was a main effect of condition on own eyes ratings, F (2, 38) = 3.41, p = .043, partial η^2 = .15. Follow-up analysis indicated that own eyes ratings were higher in the non-shifted compared to the baseline condition, p = .038, which may reflect maintenance of the own eyes perspective as the result of repeated memory retrieval (Butler et al., 2016). There was also a main effect of condition on spatial ratings, F (2, 38) = 6.18, p = .005, partial η^2 = .25, which was reflected by higher ratings compared to baseline in both the non-shifted, p = .031, and shifted conditions, p = .003. Thus, repeated retrieval of memories while adopting a particular perspective influenced some of the phenomenology of subsequent memories, but there were no differences between the shifted and non-shifted perspective conditions.

INSERT TABLE 2 HERE

Subsequent Memory Accuracy

To examine differences in subsequent memory accuracy due to shifting perspective during memory retrieval we conducted a repeated measures ANOVA on the proportion of correct items recalled in the short-answer question with the three study conditions (shifted, non-shifted, baseline) as a factor (for means and SD see Table 3). We found a main effect of condition, F (2, 38) = 16.04, p < .0001, partial η^2 = .46. Follow-up analyses indicated that subsequent memory accuracy was greater in the non-shifted compared to both the shifted perspective, and baseline conditions (see Figure 2A). Thus, there was a large effect of perspective shifting during retrieval on subsequent accuracy of memories.

INSERT FIGURE 2 AND TABLE 3 HERE

Experiment 2

One reason why shifting visual perspective during memory retrieval may reduce subsequent memory accuracy is because retrieving memories from an observer perspective reflects less encoding specificity (i.e., the match between the retrieval cues and encoding; St. Jacques & Schacter, 2013; Tulving & Thomson, 1973). To account for the influence of encoding specificity effects, in Experiment 2 we varied the effectiveness of the retrieval cue to elicit memories. One group was presented with the title and description of the mini-event (match group), and the other group was presented with the title only (mismatch group). We reasoned that if potential differences between the non-shifted and shifted perspective conditions were due to encoding specificity then increasing the match of the retrieval cue between encoding and retrieval should also increase the difference between the perspective conditions when compared to the mismatch group (i.e., an interaction).

Method

Participants

Thirty-eight fluent English speakers were included in the experiment [33 women; mean age in years (*M*) = 21.89, *SD* = 3.02; mean years of education (*M*) = 16.45, *SD* = 1.35]. They reported no history of psychiatric and/or mental health impairments, were not taking any medication that could affect cognitive function, had normal or corrected to normal vision/hearing, and had not previously participated in Experiment 1. They provided written informed consent for a protocol approved by the School of Psychology at the University of Sussex.

Procedure

The study procedure was identical to Experiment 1, except that photos were not used as retrieval cues in session 2. To manipulate encoding specificity we included two retrieval groups that varied in the match or mismatch of the retrieval cue used to elicit memories. The match group was provided with both the mini-event title and a brief description of the event that was identical to the one heard during memory encoding. In contrast, the mismatch group was provided with the title only.

Results

Subjective Ratings

Session 2. To determine potential differences in the subjective ratings made during retrieval in session 2 we conducted two separate repeated measures ANOVAs on perspective maintenance and vividness ratings, with perspective condition (non-shifted, shifted) as the within-subjects measure and retrieval group (match, mismatch) as the between-subjects factor, and Bonferroni's correction was used in the post-hoc analyses (for means and SD see Table 1).

The ANOVA on perspective maintenance rating revealed a significant main effect of perspective condition, F (1, 36) = 62.52, p <.001, partial η^2 = .64, reflecting greater ease in maintaining the indicated perspective in the non-shifted perspective (M = 3.72, SD = .69) compared to the shifted perspective condition (M = 2.84, SD = .53). Similarly, the ANOVA on vividness also showed a main effect perspective condition, F (1, 36) = 37.81, p <.001, partial η^2 = .51, reflecting greater ease in maintaining the indicated perspective in the non-shifted perspective (M = 3.47, SD = .59) compared to the shifted perspective condition (M = 3.00, SD = .49). There were no main effects of retrieval group or perspective condition by retrieval group interactions in either ANOVA. Consistent with the findings of Experiment 1, it was more difficult to maintain a shifted than non-shifted perspective during memory retrieval and these memories were also retrieved less vividly.

Session 3. A series of repeated measures ANOVAs were conducted on subjective ratings made in session 3 with condition (non-shifted, shifted, baseline) as a within-subjects factor and retrieval group as a between subjects factor (for means and SD see Table 2). There were no significant main effects or interactions. Thus, shifting perspective during retrieval did not influence the phenomenology of subsequent memories.

Subsequent Memory Accuracy

To examine differences in subsequent memory accuracy due to shifting perspective during memory retrieval, we conducted a 3 (perspective condition: non-shifted, shifted, baseline) x 2 (retrieval group: match, mismatch) ANOVA on the average proportion of accurate responses. Perspective condition was a within-subjects factors and retrieval group was a between-participants factor (for means and SD see Table 3). Bonferroni's correction was used to test post-hoc analyses. The ANOVA on memory accuracy revealed that there was no main effect of retrieval group, nor an interaction between retrieval-group and perspective condition. However, the main effect of perspective condition did not reach significance, F (2, 72) = 2.59, p = .082, partial η^2 = .07. Further inspection of the data revealed that the non-significant effect of condition was primarily due to the lack of difference from baseline in the two perspective conditions.

Given that our main interest in Experiment 2 was how visual perspective during retrieval influenced the two experimental conditions, we conducted an additional repeated measures ANOVA that excluded the baseline condition. As before, we found no main effect of retrieval-group, nor interaction. However, now there was a significant main effect of perspective condition, F (1, 36) = 7.16, p = .011, partial η^2 = .17. Inspection of the means revealed a greater proportion of correct responses in the non-shifted (M = .40, SD = .13) compared to the shifted perspective conditions (M = .37, SD = .13, see Figure 1B). Thus, as in Experiment 1, we found that shifting perspective during retrieval reduced subsequent memory accuracy compared to maintaining the same visual perspective as memory encoding.

Experiment 1 and 2

The findings from Experiment 2 replicated those from Experiment 1. One limitation of Experiment 2, however, was that there was no difference in vividness ratings in session 2 between the two retrieval groups suggesting that our manipulation of encoding-retrieval match of the retrieval cues may have been less effective than expected. Looking across the two experiments, use of the photo retrieval cues in Experiment 1, however, did result in overall higher vividness ratings during retrieval in session 2 when compared to Experiment 2, t (56) = 3.60, p = .001, d = .99. Thus, to better understand the potential influence of encoding specificity due to visual perspective, we conducted an additional repeated measures ANOVA on subsequent memory accuracy on the shifted, non-shifted and baseline conditions, with experiment as a between-subjects factor and perspective condition as a within-subjects factor. There was no main effect of experiment, F (1, 56) = .44, p = .51, partial η^2 = .01. As expected, however, these results revealed a main effect of perspective condition, F (2, 112) = 13.44, p < .0001, partial η^2 = .19, reflecting greater memory accuracy in the non-shifted than shifted perspective conditions, and the non-shifted and baseline conditions, both p's < .0001. However, the main effect of condition was qualified by a significant interaction with experiment, F (2, 112) = 5.43, p = .006, partial η^2 = .09. Post-hoc analyses revealed that subsequent memory accuracy was greater in the non-shifted than shifted perspective conditions in both Experiment 1, p = .002, and Experiment 2, p = .021.[2] In Experiment 1 memory accuracy was also greater in the non-shifted condition compared to baseline, p < .0001. In contrast, in Experiment 2 there was no difference in the non-shifted condition compared to baseline. Thus, the greater encoding-retrieval match of cues used in Experiment 1 versus 2, didn't influence the overall size of the difference in memory accuracy between the non-shifted and shifted perspective

[2] A separate One-Way ANOVA also revealed that there was no difference in the size of the difference in memory accuracy between the non-shifted and shifted conditions.

condition; however, it did impact whether the non-shifted retrieval condition differed from baseline.

When examining the effects across the two experiments, we also found that differences in subsequent memory accuracy in the retrieval conditions (i.e., difference in the non-shifted minus shifted conditions) due to perspective shifting were predicted by differences in subjective ratings made in session 2. A partial correlation controlling for the two experiments, revealed a significant relationship between differences in subsequent memory accuracy and differences in subjective ratings of vividness in the non-shifted versus shifted perspective conditions, $r = .43$, $p = .001$ (see Figure 3A). In contrast, subsequent memory accuracy was not related to differences in perspective maintenance ratings in session 2, $r = .05$, $p = .72$ (see Figure 3B). We conducted a multiple linear regression analysis to determine whether the difference in vividness ratings between the perspective conditions uniquely predicted differences in subsequent memory accuracy when including differences in perspective maintenance as an additional predictor. Although the ratings were correlated, $r = .47$, $p < .001$, collinearity assumptions were not violated, *VIF* = 1.29, *tolerance* = .78. A significant regression equation was found, F (2, 57) = 6.83, $p = .002$, $R^2 = .20$. The analysis showed that differences in perspective maintenance did not predict differences in subsequent memory accuracy, *Beta* = -.21, t (54) = -1.55, p = .13, however, differences in vividness did uniquely predict differences in subsequent memory accuracy, *Beta* = .51, t (54) = 3.69, $p = .001$. Thus, differences in the vividness of memory retrieval during perspective shifting in session 2, but not perspective maintenance, predicted subsequent changes in memory accuracy.

General Discussion

Visual perspective during memory retrieval is not merely epiphenomenal, but can reconstruct memories during their retrieval and lead to long-term changes in how memories are later remembered. The current study shows that actively shifting visual perspective in memory not only affects the phenomenological characteristics and the content of memory, but also influences the accuracy with which we remember the past. Across two experiments, we found that shifting from a dominant own eyes to an alternative observer perspective during retrieval impaired subsequent memory accuracy for complex events encoded in the lab when compared to maintaining an own eyes perspective during retrieval or baseline changes in memories due to time alone. Moreover, our results suggest that differences in the difficulty of maintaining a shifted perspective or encoding specificity cannot easily explain the accuracy differences. Instead, our data revealed that differences in the vividness of memory retrieval predicted subsequent reductions in memory accuracy due to perspective shifting. We discuss these findings and their implications below.

Our findings contribute to the growing literature on the role of visual perspective in modifying long-term memories for events. Visual perspective alters how memories are retrieved online (for a review see Rice, 2010), and these changes can persist in later memories retrieved from one's natural or spontaneous visual perspective (Bagri & Jones, 2009; Butler et al., 2016; Sekiguchi & Nonaka, 2014; St. Jacques et al., 2017). In the current study we show that shifting visual perspective during retrieval influences the accurate recall of subsequent memories for complex events that were performed in the lab, which we linked to reductions in the vividness of memory retrieval. We did not find that shifting versus maintaining visual perspective modified the phenomenology of later memory retrieval, as has sometimes been shown (Butler et al., 2016; Sekiguchi & Nonaka, 2014; St. Jacques et al., 2017). One reason may be due to the nature of retrieving memories encoded in the lab versus autobiographical memories. Controlled encoding of complex events, either in the lab or the real-world, is generally preferable over eliciting personal memories when memory accuracy must be verified (for a review see Cabeza & St Jacques, 2007). However, direct comparisons between the two types of memories can involve differences in the characteristics of memories, such as the recency of events, their emotional intensity, and baseline perspective, which could affect how visual perspective influences memory (Butler et al., 2016). The memories used here were not particularly emotional and were less than two weeks old, which could make them less prone to persistent changes in the phenomenology of memories (also see Grol, Vingerhoets, & De Raedt, 2017).

Several studies have shown that shifting perspective from an own eyes to an observer perspective reduces online ratings of subjective vividness during memory retrieval (Butler et al., 2016; Rice & Rubin, 2009; Vella & Moulds, 2014). Here we also found that shifting visual perspective reduced subjective ratings of vividness during memory retrieval. Moreover, our results revealed that differences in the vividness of memory retrieval between the shifted and non-shifted perspective conditions also predicted later impairments in the accuracy of memories. In the current study, retrieval of memories from an observer perspective may have been less vivid because they were not encoded from this perspective in the lab, and thus there was less visual information available from this novel perspective during memory retrieval (e.g., Butler et al., 2016). These findings are in line with evidence that the availability of visual information supports memory retrieval from an own eyes perspective (Rubin, Burt, & Fifield, 2003), and that verbatim rehearsal of memories in the same way they were originally experienced can also protect memories from changes in vividness over time (Butler et al., 2016; also see Campbell, Nadel, Duke, & Ryan, 2011; Svoboda & Levine, 2009). Recently, Butler et al. (2016) found that the preservation of subjective ratings of the amount of visual information due to repeated retrieval also prevented memories from naturally transforming from an own eyes to an observer perspective over time- particularly when memories were repeatedly retrieved from an own eyes versus an observer perspective. Interestingly, they also found that perspective shifting in the reverse direction, from an observer to an own eyes perspective, in a final retrieval attempt, did not lead to the recovery of visual imagery in memories. A similar effect may have occurred in the current study. In other words, rehearsing memories from an observer perspective may not only have reduced vividness ratings at one point in time, but could also have decreased the availability of visual information during subsequent retrieval. Our findings show for the first time that changes in vividness due to shifting perspective during retrieval also contributes to reductions in the accuracy of subsequent memory recall. These and other findings suggest that shifting from an own eyes to an observer perspective during retrieval potentially contributes to more permanent changes in memories (see also Berntsen & Rubin, 2006).

A number of lines of evidence have shown that retrieval is an active process that can update memories (Anderson, Bjork, & Bjork, 2000; Bjork, 1975; Hupbach, Gomez, Hardt, & Nadel, 2007; Marsh, 2007; Roediger & Butler, 2011). Theories of memory reconsolidation propose that reactivating a stable memory can render it susceptible to modification (Hardt, Einarsson, & Nader, 2010; Nadel, Hupbach, Gomez, & Newman-Smith, 2012; Winocur & Moscovitch, 2011). Our findings contribute to theoretical understanding of retrieval-related changes in memories by showing that visual perspective is a key property that can reshape long-term memories for events by altering the vividness of memory retrieval.

Recalling memories from a shifted perspective likely requires re-organising the mental images that arise during memory retrieval from a new perspective, thereby involving greater reconstruction of memories. Previous research has shown that the intensity or quality with which long-term memories are reactivated modulates the accurate recall of later memories (St. Jacques, Montgomery, & Schacter, 2015; St Jacques, Olm, & Schacter, 2013; St. Jacques & Schacter, 2013). For example, St Jacques and Schacter (2013; Experiment 2) found that differences in reliving during memory retrieval that was cued in shifted or non-shifted perspective conditions contributed to differences in subsequent memory effects. In the current study we also found that the influence of retrieval on subsequent memory is attenuated when retrieval cues were less effective in reactivating memories in the non-shifted perspective condition (i.e., no difference between baseline and the non-shifted perspective condition in Experiment 2). However, the effectiveness of the retrieval cue did not influence subsequent memory effects between the shifted and non-shifted perspective conditions, suggesting that shifting visual perspective is not identical to “weaker” reactivation of memories due to differences in encoding specificity. Instead shifting visual perspective during memory retrieval may operate by reshaping memories, perhaps by altering the vividness of mental images as they are elaborated upon during retrieval. According to the mental context shift hypothesis (Sahakyn & Kelley, 2002), changes in context between encoding and retrieval can lead to forgetting (also see Mensink & Raajimakers, 1988; 1989). A similar mechanism could occur when shifting visual perspective during memory retrieval, because adopting an alternative visual perspective requires greater remapping of the spatial context of memories compared to maintaining the same visual perspective as encoding.

An alternative explanation of our findings is that difficulty in maintaining the observer vantage point could have contributed to differences in subsequent memory accuracy between the perspective conditions. Indeed, shifting perspective likely requires additional and potentially effortful cognitive process whereby the individual has to update the spatial context of the memory so that they are now a spectator watching the scene. In the current study, the short amount of time (i.e., 7.5s) allowed to retrieve memories from the shifted perspective may have not been sufficient to both update one’s egocentric representation in the memory and to retrieve a sufficient level of memory. For example, we found that maintaining an alternative observer perspective during memory retrieval was harder than maintaining the same own eyes perspective as memories were originally encoded (also see Eich et al., 2009; St. Jacques et al., 2017), and that perspective maintenance ratings were correlated with vividness ratings. However, differences in perspective maintenance between the perspective conditions were unrelated to differences in subsequent memory accuracy. Moreover, other research has demonstrated shifting visual perspective reduces memory vividness even when retrieval is unlimited in time (e.g., Berntsen & Rubin, 2006; Butler et al., 2016). Thus, the reduction in subsequent memory accuracy shown here cannot be readily explained by differences in difficulty. Future research should aim to directly investigate these issues by modulating the duration of memory retrieval and/or by equating the difficulty of retrieving memories from own eyes and observer perspectives.

Our findings have important implications in forensic settings, particularly with protocols used for eyewitness testimony. For example, the cognitive interview partly relies on the mnemonic effect of changing perspective to facilitate retrieval of accurate information (Geiselman et al., 1984). Adopting an alternative perspective may sometimes benefit the recall of details that would have been otherwise missed (e.g., Anderson & Pichert, 1978). Our findings argue against the generalizability of using visual perspective shifting as an effective interview technique. One important difference between the current findings and changes in perspective reported in these settings, is that here we manipulate egocentric perspective (i.e., self-centred frame of reference) rather than asking people to directly adopt another person's perspective (e.g., the cashier being held up in a convenience store). Better understanding these differing aspects of perspective taking on memory and its potential impact on memory accuracy and other types of changes in memories will be important directions for future research.

Conclusion. One of the main assumptions about visual perspective is that adopting an observer perspective reflects the transformation of memories (e.g., Schacter, 1996; Sutin & Robins, 2008). In the current study we show for the first time that deliberately shifting perspective from an own eyes to an observer perspective at retrieval can have detrimental effects on the subsequent accuracy of memories. Effortful reconstructive processes involved in updating egocentric perspective during memory retrieval, by adopting the viewpoint of an observer, decreased the subjective vividness of memories online, which in turn predicted the decreased accuracy of these memories in later retrieval. Better understanding the nature of observer perspectives in transforming long-term representation of memories will expand our theoretical understanding of visual perspective in memories, as well as the impact of the use of this technique in applied forensic and clinical settings.

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Figures

Figure 1. *Experimental design*. The study took place in three separate sessions. In Session 1, participant completed a series of hands on mini-tasks. In Session 2, they were asked to retrieve some of the mini-events from an own eyes (non-shifted condition) and some from an observer perspective (shifted condition). In Experiment 1, they were given photographs of the mini-events taken from the two different perspectives; in Experiment 2 they were either presented with a description of the mini-event (match group) or with no retrieval cue (mismatch group). In both experiments, participants were then asked to rate their ability to maintain the given perspective and the degree of vividness of each retrieved mini-event. In Session 3, memory accuracy was tested using a series of short-answer questions about each of the mini-events followed by subjective ratings on characteristics of memory retrieval.

Figure 2. *Subsequent memory accuracy*. (A) In Experiment 1, shifting perspective during retrieval reduced accuracy for subsequent memories when compared to the non-shifted perspective and baseline conditions. (B) In Experiment 2, both the match and mismatch groups showed a decrease in memory accuracy following a shift in perspective. Error bars reflect within-subject standard error.

Figure 3. *Correlation between subsequent memory accuracy and subjective ratings*. (A) There was a positive relationship between differences in subsequent memory accuracy and differences in vividness ratings made in session 2 in the non-shifted and shifted perspective conditions. (B) There was no relationship between differences in subsequent memory accuracy and differences in perspective maintenance ratings made in session 2 in the non-shifted and shifted perspective conditions.

Appendix

Titles and brief descriptions of the mini-events.

1) Shred the Documents: Shred the paper and pack the objects in the bag.
2) What's in the Container? Have a go and guess what's in the containers.
3) Create Play Doh: Form a "beach" scene with play doh and send a message.
4) Dress the Balloon: Make the balloon into a person and take a photograph.
5) Recite the Poem: Record yourself as you recite and act out the poem.
6) Build a Tower: Build the tallest tower you can with the materials.
7) Wrap the Present: Gift-wrap the bell with the materials provided.
8) Play the Guitar: Assemble the guitar and use it to copy a tune.
9) Marble Game: Flick the marbles into the openings in the cups and keep score.
10) Polish the Shoes: Prepare the shoes with polish and do a trick.
11) Frog Pond: Free the frogs into the pond and feed them.
12) Hidden Treasure: Find the treasure and hide it in the sand.
13) The Fun House: Make your way through the activities in the fun house.
14) Fishing Expedition: Collect the fish and prepare sushi.
15) Tangram Puzzle: Fashion a cat from the puzzle pieces.
16) Make a Book: Make a book and write a story.
17) Arrange Flowers: Create a flower garden.
18) Paint Art: Design a piece of artwork.
19) Drawing to Music: Draw the items on the cards and listen to music.
20) Chemistry Recipe: Create a volcanic eruption.
21) Geo Board: Add the pushpins to the board to create a shape.
22) Fold the Box: Fold the box while making the ball bounce.
23) Prepare a Pizza: Prepare a bespoke pizza.
24) What's the Loudest?: Make sounds and order them from lowest to highest pitch

Table 1. Means (with standard deviations) for subjective ratings in session 2 perspective manipulation of experiment 1 and 2

	Experiment 1		**Experiment 2**			
			Match		*Mismatch*	
Subjective Rating	*NS*	*S*	*NS*	*S*	*NS*	*S*
Perspective Maintenance	4.01 (0.49)	3.32 (0.71)	3.62 (0.66)	2.89 (0.53)	3.81 (0.72)	2.78 (0.54)
Vividness	3.91 (0.47)	3.54 (0.70)	3.40 (0.56)	2.97 (0.45)	3.54 (0.64)	3.03 (0.54)

Note: (NS) = non-shifted condition; (S) = shifted condition

Table 2. Means (with standard deviations) for subjective ratings in session 3 of experiment 1 and 2.

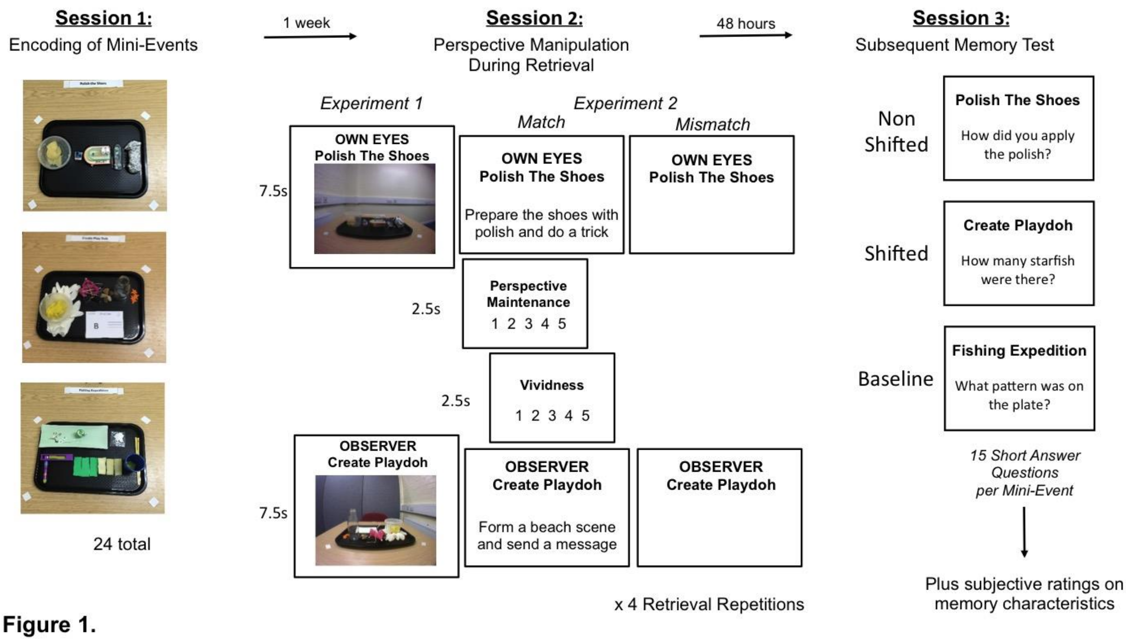
	Experiment 1			**Experiment 2**					
				Match			*Mismatch*		
Subjective Rating	*NS*	*S*	*BA*	*NS*	*S*	*BA*	*NS*	*S*	*BA*
Reliving	4.18 (1.29)	4.17 (1.51)	4.05 (1.37)	3.92 (0.98)	3.87 (0.86)	3.66 (0.96)	3.85 (1.02)	3.83 (1.06)	3.67 (1.15)
Emotional intensity	3.05 (1.19)	2.99 (1.46)	2.72 (1.18)	2.78 (1.35)	2.79 (1.19)	2.57 (1.11)	2.58 (1.33)	2.51 (1.18)	2.59 (1.38)
Own Eyes perspective	5.13 (1.31)	5.08 (1.53)	4.83 (1.44)	5.08 (1.28)	5.13 (1.21)	4.95 (1.28)	4.75 (1.01)	4.83 (1.15)	4.89 (1.07)
Observer perspective	2.14 (0.93)	2.21 (0.96)	1.98 (0.82)	2.04 (0.91)	2.09 (0.86)	2.08 (0.91)	2.22 (0.94)	2.39 (1.02)	2.35 (1.03)
Visual	4.31 (1.43)	4.26 (1.37)	3.98 (1.21)	4.09 (0.87)	4.01 (0.97)	4.04 (0.92)	3.85 (0.73)	3.92 (0.72)	3.99 (0.88)
Sensations	3.78 (1.15)	3.89 (1.16)	3.70 (1.21)	3.69 (1.02)	3.63 (0.82)	3.49 (0.87)	3.40 (1.07)	3.49 (1.22)	3.39 (1.21)
Actions	4.69 (1.33)	4.65 (1.31)	4.43 (1.34)	4.47 (1.04)	4.44 (0.94)	4.41 (0.91)	4.46 (1.06)	4.47 (1.16)	4.47 (1.17)
Temporal order	3.56 (1.23)	3.63 (1.22)	3.29 (1.01)	3.31 (0.82)	3.29 (0.74)	3.32 (0.68)	3.56 (0.75)	3.60 (0.92)	3.53 (1.00)
Spatial arrangement	3.91 (1.20)	3.94 (1.27)	3.56 (1.02)	3.52 (1.22)	3.49 (1.16)	3.38 (1.11)	3.63 (1.13)	3.60 (1.18)	3.77 (1.26)
Accuracy	3.55 (1.25)	3.61 (1.26)	3.27 (1.12)	3.28 (0.92)	3.18 (0.97)	3.16 (0.83)	3.24 (1.06)	3.28 (1.16)	3.40 (1.18)

Note: (NS) = non-shifted condition; (S) = shifted condition; (BA) = baseline

Table 3. Means proportion correct (with standard deviations) of memory accuracy of experiment 1 and 2.

Experiment 1			**Experiment 2**					
			Match			*Mismatch*		
NS	*S*	*BA*	*NS*	*S*	*BA*	*NS*	*S*	*BA*
0.45 (0.13)	0.40 (0.12)	0.37 (0.12)	0.39 (0.13)	0.35 (0.13)	0.37 (0.16)	0.41 (0.14)	0.39 (0.13)	0.39 (0.11)

Note: (S) = (NS) = non-shifted condition; (S) = shifted condition; (BA) = baseline



Session 1:
Encoding of Mini-Events
24 total
1 week
Session 2:
Perspective Manipulation During Retrieval
48 hours
Session 3:
Subsequent Memory Test
Experiment 1
Experiment 2
Match
Mismatch
7.5s
OWN EYES Polish The Shoes
OWN EYES Polish The Shoes
Prepare the shoes with polish and do a trick
OWN EYES Polish The Shoes
2.5s
Perspective Maintenance
1 2 3 4 5
2.5s
Vividness
1 2 3 4 5
7.5s
OBSERVER Create Playdoh
OBSERVER Create Playdoh
Form a beach scene and send a message
OBSERVER Create Playdoh
x 4 Retrieval Repetitions
Non Shifted
Polish The Shoes
How did you apply the polish?
Shifted
Create Playdoh
How many starfish were there?
Baseline
Fishing Expedition
What pattern was on the plate?
15 Short Answer Questions per Mini-Event
Plus subjective ratings on memory characteristics

Figure 1.

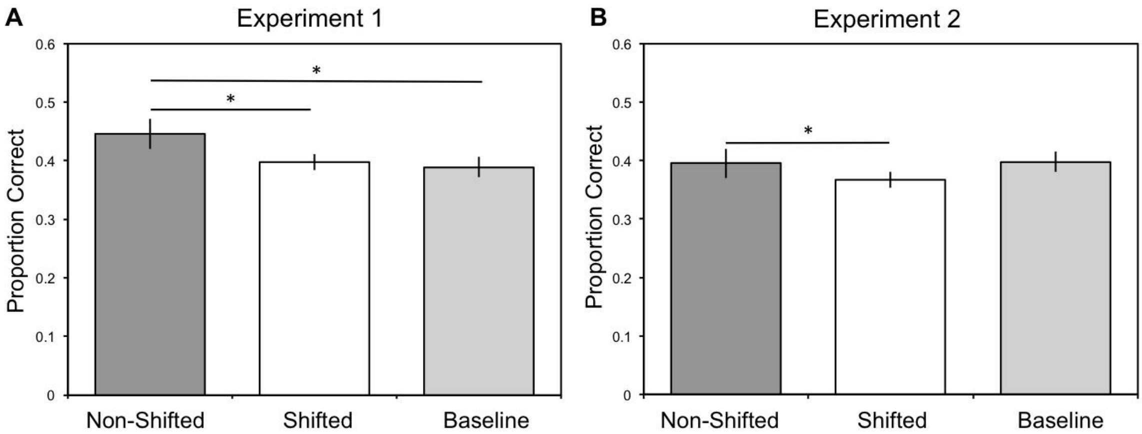

A
Experiment 1
Proportion Correct
0.6
0.5
0.4
0.3
0.2
0.1
0
*
*
Non-Shifted
Shifted
Baseline
B
Experiment 2
Proportion Correct
0.6
0.5
0.4
0.3
0.2
0.1
0
*
Non-Shifted
Shifted
Baseline

Figure 2.

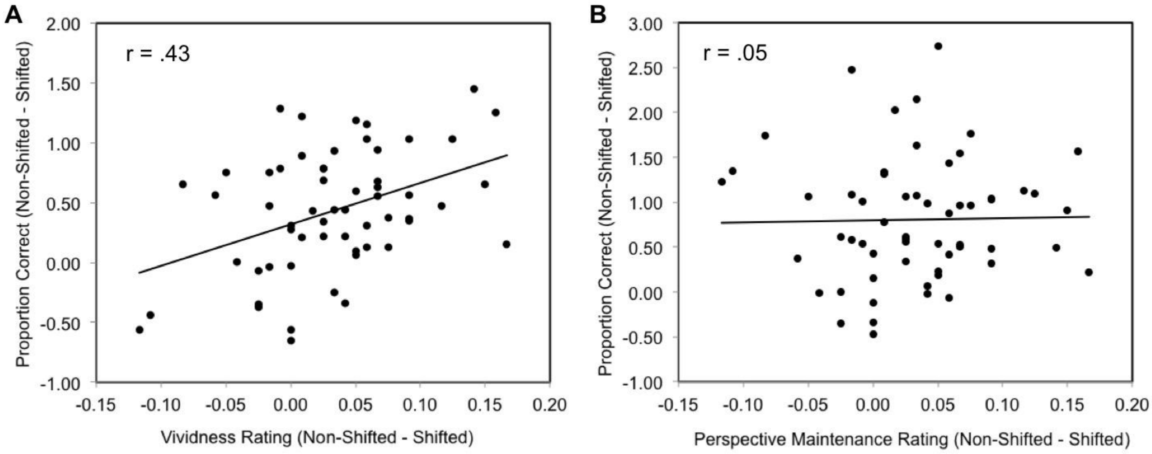

A
r = .43
Proportion Correct (Non-Shifted - Shifted)
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
Vividness Rating (Non-Shifted - Shifted)
B
r = .05
Proportion Correct (Non-Shifted - Shifted)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
Perspective Maintenance Rating (Non-Shifted - Shifted)

Figure 3.